MULTIPLE POLLEN FORMS IN TWO SPECIES OF THE GENUS STEVIA (COMPOSITAE)

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Abstract. Races occur in both *Stevia pilosa* and *S. purpurea* showing different types of pollen. In each species are found plants (a) lacking distinct pollen, (b) with small tricolpate pollen, (c) with larger asymmetric pollen, and (d) with double pollen. These pollen types probably reflect cytological races.

Plant taxonomists tend to think of pollen as a relatively stable character by which species, genera, and even higher categories of plants may be recognized. Few pollen variations in a single species are reported and most of these involve size differences correlated with polyploidy (Stebbins, 1950). For this reason the discovery of multiple pollen types in some species of the genus *Stevia* seems significant.

The pollen observations reported here are from specimens of two Mexican species of *Stevia* deposited in the U. S. National Herbarium. These specimens of *S. pilosa* Lag. and *S. purpurea* Pers. conform with the concepts in the treatment of *Stevias* of North America (Robinson, 1930). Each species as recognized here appears uniform in all morphological characters other than pollen. The two species share many characters such as small, entire, elliptical, and sessile leaves, and they seem closely related. However, *S. pilosa* is characterized by a pappus lacking setae and which remains immersed in the floral bracts at maturity, and also by the larger leaves subtending the floral heads. *Stevia purpurea* has distinct pappus setae which are exserted at maturity, and the leaves subtending the floral heads are usually very small.

Stevia is a genus of perhaps 300 species restricted to tropical and subtropical areas of the Americas. The basic pollen type in the genus is a tricolpate grain designated here as *Stevia* pollen type I. At least 30 species indigenous to Mexico and the southwestern United States show a unique type of pollen designated here as *Stevia* pollen type II. In *S. pilosa* and *S. purpurea*, the two species that have been studied most completely, all four following pollen types are present:

Aborted: In flowers that are otherwise completely mature, anthers are immature with exothecial cells underdeveloped and distinct pollen grains absent.

Type I: Pollen grains spherical, averaging 25 μ in diameter, tricolpate with intervening spinose faces (Figures 1a, 2a). These are usually radially symmetric but occasionally show one of the faces much larger than the others. This latter condition is particularly evident in one plant *(Schaffner 586)* where the type I pollen occurs intermixed with type II.

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Type II: Pollen grains spherical, averaging 30-40 μ in diameter, the furrows and the four intervening spinose plates are usually very asymmetrically arranged most often with one rectangular plate extending ¾ of the way around the grain (Figures 1b, 1d, 2b). These grains possibly represent a modified tetracolpate grain, a form which is sometimes present among the variations.

Type III: Pollen grains elongated, short cylindrical or dumbbell shaped, lesser axes 30-35 μ in diameter, surface markings similar to those of type II but complicated by the double nature of the grain. (Figures 1c, 1e, 2c, 2d).

Repeated examinations show that the pollen types in one anther of any one plant occur in other anthers throughout that plant. If one anther contains type III pollen, all anthers on the plant contain this type of pollen. In plants where both pollen types I and II or II and III are present, both types occur in each anther. In the cases where two types of pollen are present in an anther they are present in nearly equal numbers and are thoroughly intermixed. It seems probable that each pollen mother cell gives rise to both types.

The specimens examined with notes of types of pollen present are given in Tables I and II.

If there are differences between the type I pollens of *S. pilosa* and *S. purpurea*, or between the type II pollens of these species, they are very subtle. However, the type III pollen observed in one plant of *S. purpurea* (*Palmer 463* in part) is very distinct from type III pollen in *S. pilosa*. In *S. purpurea* (Figure 2c) the major furrows are oriented longitudinally, while in *S. pilosa* (Figure 2d) they are oriented transversely. In *S. pilosa* this results in a distinctly girdled appearance of the type III pollen.

The development of pollen types in *S. pilosa* and *S. purpurea* seems to be controlled genetically. There is no obvious correlation with such environmental factors as elevation or progression of flowering season. The pollen types are consistent within individual plants, but often plants collected in the same region, at the same time, and even mounted on the same herbarium sheet may contain different pollen types.

Any attempt to explain the different pollen types in the two species of *Stevia* should consider the following points: (a) the distinctions between pollen type I and the others include a difference in size; (b) that two different types of pollen are capable of occurring in a single anther, probably being derived from a single pollen mother cell; (c) that in some of the plants no distinct pollen is formed; (d) that for *S. purpurea* meiotic configurations showing a variable number of bivalents and univalents, 17(2 to 8_{II}, 30 to 18_{I}), have been reported (Powell and Turner, 1963).

Differences in pollen size are often associated with polyploidy (Stebbins, 1950). Chromosome number of $x = 11$, 12, and 17 have been re-

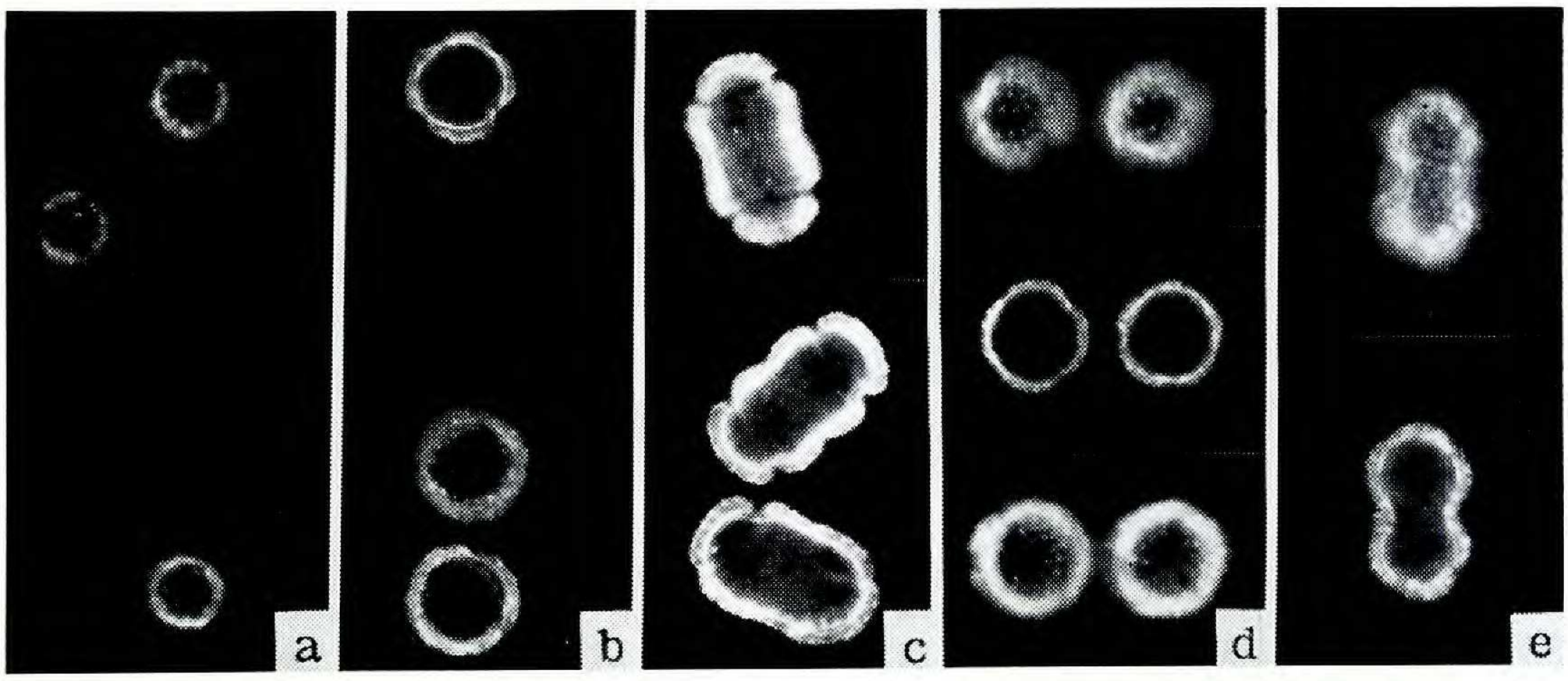

Fig. 1. *Stevia pollen* × 215. (a) *S. pilosa* type I, *Stanford, Taylor, & Lauber 2410;* (b) *S. pilosa* type II, *F. Salazar s.n.;* (c) *S. pilosa* type III, *Pringle 9547;* (d) *S. purpurea* type II, *Lundell & Lundell 12378;* (e) *S. purpurea* type III, *Palmer 463.*

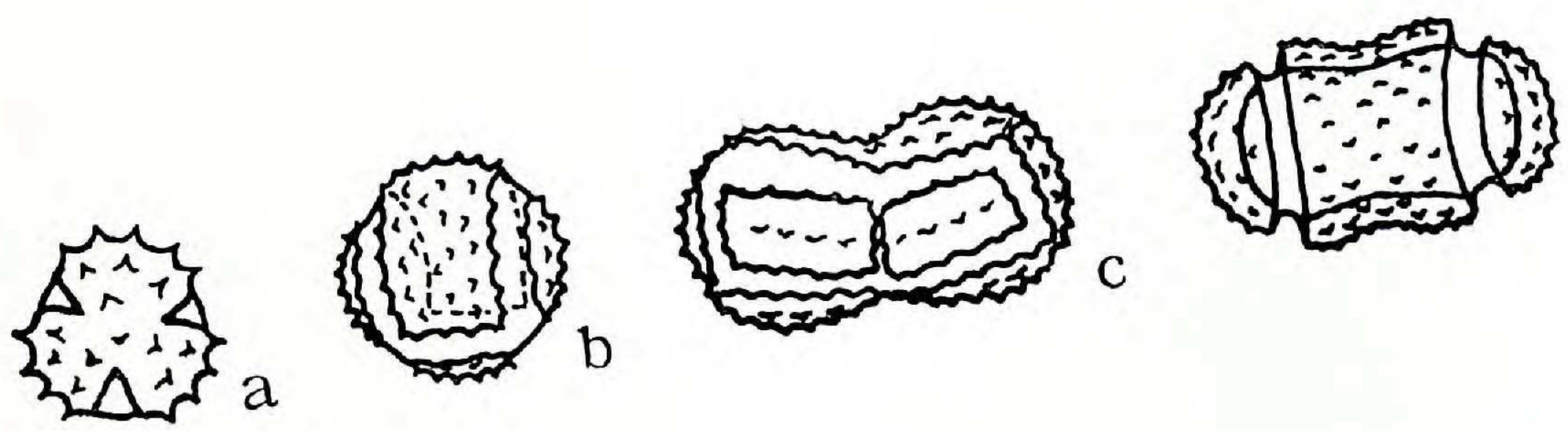

Fig. 2. *Stevia* pollen. (a) type I; (b) type II; (c) *S. purpurea* type III; (d) *S. pilosa* type III.

ported for the genus (Powell and Turner 1963; Turner and Flyr, 1966; Turner and King, 1964). Many of the species in which the higher number has been reported are species in which pollen type II has been observed.

At least some aspects of the pollen form are controlled by the individual haploid pollen grain as is shown by the development of two distinct types of pollen in each anther of some specimens of both species. In one case *(Schaffner 586)* the type I pollen seems to be modified slightly in the presence of type II pollen. This induced asymmetry could be the result of stresses present in tetrads containing two pollen types of different size. This explanation assumes that the genetic mechanism controlling pollen form is under simple Mendelian control.

The appearance of the type III pollen suggests a cell in which division

has been arrested. The pollen grains vary slightly in length and in degree of central constriction, but still show amazing uniformity in shape. Possibly chromosome irregularities in meiosis are involved. If so these irregularities are such that they do not prevent the completion of the meiotic division sequence of the nucleus. This explanation meets complications in light of the specimens having pollen types II and III in each anther. An alternate possible cause is suggested by the lobed microspore derivatives observed in colchicine treated *Coriandrum sativum* by Joshi and Raghuvanshi (1965). In the *Coriandrum* variant the highly lobed grains were found admixed with normal grains from the same tetrad. The lobed grains of *Coriandrum*, however, lacked the uniformity seen in *Stevia*.

We have provisionally concluded that cytological races are responsible for the multiple pollen form in *S. pilosa* and *S. purpurea*. The cytology involved is as yet unknown, but a review of the genus *Stevia* including cytological and biochemical investigations is planned by A. M. Powell of Sul Ross State College, Alpine, Texas.

Table I. Specimens of *Stevia pilosa* examined.

	Pollen Types			
Collection Data	*Absent*	*I*	*II*	*III*
Hidalgo: Sierra de Pachuca, 8 Sep 1899, *Pringle 8236*.	X			
Hidalgo: between Somoriel and Las Lajas, 5 Aug 1905, *Rose, Painter* & *Rose 9232*.	X			
Hidalgo: Cuyamaloya Station, 6 Aug 1906, *Pringle 13781*.	X			
Federal District: Ajusco, 18 Aug 1926, *Fisher 101* (in part).		X		
Federal District: San Andrés, Aug 1932, *Lyonnet 2956*.		X		
Mexico: 30 mi west of Toluca, 17 Jul 1940, *Hitchcock* & *Stanford 7222*.		X		
Nuevo Leon: Pablillo, southwest of Galeana, 28-30 Jun 1934, *Pennell 17089*.		X		
Tamaulipas: 3 mi north of Miquihuana, 12 Jul 1949, *Stanford, Taylor* & *Lauber 2410*.		X		
Federal District: Ajusco, 18 Aug 1926, *Fisher 98*.		X	X	
Mexico: Flor de Maria, 3 Sep 1890, *Pringle 3478*.		X	X	
Mexico: San Bartolito, 4 Sep 1913, *F. Salazar s.n.*			X	
Puebla: Boca del Monte, Aug 1907, *Purpus 2642*.			X	
Mexico: pris Santa Fe, 5 Jul 1866, *Bourgeau 606*.			X	X
Federal District: Eslaba, 7 Sep 1901, *Pringle 9547*.				X
Federal District: Eslaba, 18 Sep 1903, *Pringle 11583*.				X
Veracruz: Mt Orizaba, 8 Aug 1891, *Seaton 275*.				X

Table II. Specimens of *Stevia purpurea* examined.

Collection Data	*Pollen Types*			
	Absent	*I*	*II*	*III*
San Luis Potosí: Sierra de San Miguelito, 28 Jul 1934, *Pennell 17699*.	X			
San Luis Potosí: San Jose Pass, 22 Jul 1890, *Pringle 3176*.		X		
San Luis Potosí: 5 km west of Guadalcázar, 3 Oct 1954, *Rzedowski 5074*.		X		
San Luis Potosí: San Luis Potosí, 1879, *Schaffner 586*.		X	X	
Durango: Santiago Papasquiaro, Aug 1896, *Palmer 456*.			X	
Durango: El Oro to Guanaceví, 14-16 Aug 1898, *Nelson 4738*.			X	
Durango: Otinapa, 25 Jul - 5 Aug 1906, *Palmer 463* (in part).			X	
Durango: Empalme Purisima, 27 Aug 1934, *Pennell 18251*.			X	
Federal District: Ajusco, 18 Aug 1926, *Fisher 101* (in part).			X	
Hidalgo: trail to Real del Monte on Mt Cerro Ventosa near Pachuca, 13 Sep 1899, *Pringle 7899*.			X	
Hidalgo: between Pachuca and Real del Monte, 31 Aug 1903, *Rose & Painter 6696*.			X	
Mexico: off Toluca road, 14 Aug 1943, *Lundell & Lundell 12378*.			X	
Puebla: Boca del Monte, Aug 1907, *Purpus 2552*.			X	
San Luis Potosí: San Luis Potosí, 1878, *Parry & Palmer 323*.			X	
San Luis Potosí: San Luis Potosí, 1878, *Parry & Palmer 323½*.			X	
San Luis Potosí: San Luis Potosí, 18-20 Aug 1902, *Palmer 37*.			X	
San Luis Potosí: Alvarez, 28 Sep - 3 Oct 1902, *Palmer 167*.			X	
Sinaloa: El Carrizo, 1925, *Ortega 6005*.			X	
Durango: Otinapa, 25 Jul - 5 Aug 1906, *Palmer 463* (in part).				X

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